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On Static vs. Dynamic Line Ratings in Renewable Energy Zones

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The integration of variable renewable energy (VRE, solar and wind) resources poses significant challenges for transmission network planning and operation. To connect VRE resources to the main grid and deliver their output to load centres, transmission networks need to be expanded and upgraded. However, transmission development is a complex and lengthy process that involves various technical, economic, environmental, social, and regulatory hurdles. Transmission projects can face delays, cost overruns, along with opposition from landowners, communities, and environmental groups. Moreover, transmission assets are subject to physical constraints and operational limits that affect their ability to transfer power reliably and efficiently.

One way to enhance the performance and utilisation of existing transmission assets and any subsequent augmentations, particularly for Renewable Energy Zones, is to use real-time dynamic line ratings (DLRs) instead of static line ratings. In the Queensland region of Australia’s National Electricity Market, transmission line ratings have been conservative estimates of the maximum power transfers reflecting the conditions relevant for a power system dominated by a thermal fleet high, viz. ambient temperature, low wind speeds, and high solar radiation – the conditions that matched maximum peak demand. DLRs are calculated based on real-time measurements of the conductor temperature, sag, tension, wind speed, and direction, and other relevant factors. DLRs can vary significantly over time and space, depending on the prevailing weather conditions and the power flow on the line. DLRs can provide more accurate and timely information on the available transmission capacity and enable higher power transfers when conditions are favourable, without compromising the safety and reliability of the line.

In this article, the use of DLRs is analysed for a Renewable Energy Zone (REZ) in Queensland. A REZ is a designated area with high-quality VRE resources and coordinated transmission development to facilitate the connection of multiple VRE projects. The REZ considered is a 275kV radial line connecting several wind and solar farms to the main grid. The analysis compares and contrasts VRE hosting capacity of the REZ under static and DLRs, using optimisation modelling and historical weather data. The analysis also examines the impact of adjusting Frequency Control Ancillary Services (FCAS) in order to hold power system security otherwise constant. Optimisation modelling finds that switching from static to DLRs can increase the wind hosting capacity of the REZ by more than 60%, from about

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1700MW to over 2800MW, with minimal changes in the transmission asset base. Furthermore, dynamically adjusting the FCAS requirements can further enhance the VRE hosting capacity and reduce the curtailment of VRE generation.

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